the substage removed and the body racked down so as to focus through the empty stage upon the table, a block or box, or an extemporized stage occupying the usual position of the mirror and illuminated by the mirror after the method suggested by Mr. James Smith. In this case it is desirable to increase the working distance between the prism and the object by varying the lenses employed. Thus a one-and-a-half-inch objective at from three and three-fourths to five and three-fourths inches from the erector will give powers of six to fifty diameters and working distance from prism of seven to ten inches. The erector may also be removed an inch or more from the prism. When this latter arrangement is to be used exclusively, placing the object at from eight to ten or twelve inches from the prism, as in many students' microscopes, the apparatus is further simplified by screwing a two-inch objective into the nose-piece in its usual position, as an erector, and screwing or sliding over it an adapter carrying a-one-and-a-half or two-inch objective from four to six inches lower down Some contrivance is required to illuminate transparent objects under the lower powers ; but opake and translucent objects on a black ground can be dissected and manipulated with great facility.

The same erecting arrangement can be used in connection with monocular microscopes that have no draw-tube and therefore cannot use an erector in the usual position. It may also be used as a means of working Wenham's and other binoculars, with high powers. With powers of five hundred or one thousand diameters, however, it is still difficult to obtain good definition or to fully light both fields.

THE RATTLESNAKE AND NATURAL SELECTION.

BY PROF. N. S. SHALER.

For some years I have been teaching that the tail appendage of the rattlesnake was not to be explained on the doctrine of natural selection, inasmuch as it could contribute in no way to the advantage of the animal. It seemed to me quite clear that it was rather calculated to hinder than to help the creature in the race of life by warning its prey of its presence. Nor did it seem easy to ac-

count for its existence by supposing that it was used as a sexual call and had been brought up by natural or sexual selection for some such office. The burrowing habits of the serpents would seem to make sexual calls almost unnecessary and there is no evidence to make a reasonable basis for belief that rattlesnakes exercise any such choice in pairing as would lead to the development of this very singular appendage. Last summer, however, I had a long desired opportunity of examining a little into the habits of the rattlesnake and obtained some results which have served to shake my confidence in the opinions I had held as to the usefulness of his rattle. The observations are, as it will be seen, rather insufficient for a determination of the points in question, but it may be long before I am able to add to them, so I give them now hoping that some one with better opportunities for studying the ways of this interesting creature may either confirm my opinion or refute it.

The first and only living and active rattlesnake which I met on a carriage journey of some months' duration made during the past summer through that part of the Appalachian chain where these serpents most abound was in the middle of a road near the Kishicoquillas Valley, Pennsylvania. As the sound of my carriage disturbed the surly fellow in his pleasant basking place in the dusty way, he begun to sound his warning when we were over a hundred feet from him. Although quite accustomed to the sound, having had specimens captive for months at a time, I mistook it for that made by our "locust," the *Cicada rimosa* Say, nor did I perceive the error until my companion, Mr. A. R. Crandall, called my attention to the serpent when we were within forty feet of it. My wife and child, a little girl of eight years, who were in the carriage also mistook the noise for that made by the Cicada, which was abundantly familiar as it had been for a long time the most accustomed sound heard while we were travelling through the wooded mountain country.

I have found that the note of the rattlesnake is recognized by many persons as indistinguishable from the sound made by the Cicada. Professor Brewer, whose long experience in the service of the California Geological Survey gave him quite unrivalled opportunities for becoming familiar with the sound made by this reptile, tells me that he was on one occasion at least in great danger of being bitten by one of these animals on account of having

supposed that its persistent rattle was only the whirring of a locust. The range in pitch in the rattling sound of the snake is quite great; it is even difficult to understand how sharp it can be from a study of the sound made by the animals tamed by captivity, but at the same time the note of the locust is also very variable so that one is not able to discriminate by this means. The reader will doubtless have caught the main point towards which these facts so plainly tend, namely, that the imitation of the note of the locust may possibly be of high value to the rattlesnake. The Cicada furnishes the most satisfactory mouthful to many of our birds. Almost every observer of the life of our woods and fields, has seen a bird spying around a branch whence came the whirring of a locust; suddenly there would be an end of the monotonous sound, and a moment after the bird would be seen, beating the wings off the insect by pounding it against the ground. It is quite evident that any animal which preyed upon birds would gain a decided advantage from being able to imitate the sound made by the creatures on which the birds fed, so that we can well imagine that those snakes endowed with the power of attracting birds would be the best fed and multiply the most rapidly. From this point of view we can also understand how it is that birds have been seen fluttering around a rattlesnake without calling into play the unreasonable agency of fascination; the bird in this case being in search of his food and decoyed into the range of the serpent's spring.* It is a well known fact that birds, even those which have the best determined notes, are easily misled by sounds which approach, even though imperfectly, the calls of their species or the sounds of their prey, so that the imperfections in the note of a rattlesnake when considered as an imitation of the Cicada cannot count much as an argument against this view.

If this view be correct, then we must regard the rattle of the rattlesnake as a useful appendage, and not an instrument calculated to do it injury by warning its prey of its presence.† But it

*I had an opportunity, recently, of seeing a living Cobra di Capello in a state of excitement. The first impression was how entirely unlike any other serpent it was. The broad, flat banner-shaped neck upon the slender staff of the body would readily lead one to suppose that it was something very different from a snake. I can readily imagine that animals which had learned, by selection or otherwise, to shun creatures shaped like serpents, would be easily misled by the strange shape of the cobra and fail to avoid it or even be attracted towards it by the curiosity which animals often show to see closely or even smell any strange object.

† Rattlesnakes of the genus Crotalophorus make little or no noise with the imperfect

is by no means so easy, even if we allow all that can be claimed for natural selection, to account for the development of this appendage. The following seems to me the most satisfactory conception of its evolution, looking at the matter from Mr. Darwin's point of view. It is a fact well known, doubtless, to those who have observed serpents, though I find no mention of it in the works I have consulted, that many serpents, when in a state of excitement vibrate the end of their tail just as the rattlesnake does.* This movement is likely enough the same in character as that which occurs in the hinder part of the spinal column among higher animals under excitement. The wagging of the dog's tail is a rhythmical movement of essentially the same character as the movement of the rattlesnake. Taking the same line of argument as that adopted by Mr. Darwin with regard to the monthly phenomena observable among the mammalia, it could be claimed that the tendency to move the tail was explicable on the following grounds. During more than half the lifetime of the group of vertebrates, from the point of their presumed origin at the close of the Silurian down to the present day, the caudal portion of the body was used as the propelling agent. Fishes, with slight exceptions, propel themselves by a reciprocating movement of the tail. All conditions of excitement at once manifest themselves in the violent movement of this part of the body. Whether in flight or chase or under the influence of sexual excitement, this movement is the important element of success. It is by no means surprising that the motion which was for ages the point which natural selection operated most intensely, for those forms which had the capacity for making this alternate movement of the tail with the greatest rapidity would be most successful in flight or chase, should have survived its usefulness and remained as a mere feature of expression in most of our animals. It may be remarked in

rattles of the tail. In this genus, therefore, there could have been no advantage derived from imitation. It may be said, however, that the rattles which have little functional value in this genus, if making a sound be their real function, are even more irregular in number and shape than in the Crotalus. The truth probably is that there is an inherent tendency to form rattles in this group of serpents and these structures are seized upon by natural selection and made functional.

*Since the above matter was put in type, I have learned that Prof. Jeffries Wyman made a communication to the Boston Society of Natural History, concerning the occurrence of this movement in the tails of snakes other than the rattlesnake, some two or three years ago. I have failed to find any notice of the communication in the Proceedings of the Society, though there can be no doubt that this eminent naturalist should be credited with the priority on this point.

passing that the obstinate survival of the tail among the vertebrates may be accounted for by the intense bodily inertia, if we may so call it, which causes the energy of survival of useless structures to be proportionate to the length of time which they have been of use to the groups to which they belong. It is natural enough that a part of the body situated at one of the regions of manifold relations as the tail is, and unappropriated to any special function, should be put to use in various ways, as a prehensile instrument by some monkeys and other animals, or a building tool by the beavers, as a fly-brush by many others, etc.

Mr. Herbert Spencer has already suggested that the wagging of the dog's tail and similar movements of that appendage is in fact an escape of nervous force restrained from other modes of expression at the moment. Looking at the matter from this point of view, which is doubtless quite satisfactory, we may reconcile it perfectly with the views which have just been presented by supposing that the ancient and no longer functional channel of escape for nervous force, the tail, has remained the way of outlet for the suppressed energy of the animal. The older the channel the less easy it is to close it either by volition or by natural selection.

Be the cause of the persistence of the tail and its movement what it may, we are still justified in assuming as the starting point, that the progenitor of the rattlesnake had the alternating motion of the tail common among snakes. It is the opinion of some herpetologists that the rattles are the remains of the skins successively shed by the animal. The rate of development of the rattles, together with the fact that the skins of some serpents are more imperfectly detached from the region about the tail than at other parts of the body, makes this view very probable. Let us suppose that we had a group of poison-fanged serpents, accidentally tending to keep the tail skin in the peculiar fashion of rattlesnakes and that in some of these it was persistent enough to make the whirring sound of the Cicada when the tail was rapidly moved under excitement. These would survive and breed the most surely and so that feature would become hereditary. The great variability in the number of rattles in the different forms of rattlesnakes and the late time of their development, even among those which differ in no other regard, would seem to indicate that this structure has not yet been firmly fixed by long inheritance.

The reader will please not suppose that because I have boldly

followed the lead of the most advanced of the champions of natural selection that I am convinced of its sufficiency as an explanation of the great diversities which exist among animals or of its being sufficient basis for an explanation of the snake's rattle. But having been driven step by step from a decided opposition of the whole theory and compelled to accept it as a *vera causa*, though I think one much more limited in its action among animals than Mr. Darwin believes, I feel it to be my duty to examine every one of those points upon which I have relied for evidence against it.

It must be confessed that the case of the rattlesnake seems to me no longer the bar to the acceptance of the theory it once did.

REVIEWS AND BOOK NOTICES.

NORWEGIAN ZOOLOGY.* — The thoroughness and zeal shown by the Scandinavian naturalists in working up minutely the fauna of their shores is remarkable. While the land animals and plants of the country of Linnæus and Fabricius have been most zealously described, of late years no region has been so thoroughly explored with the dredge and net as the coast of Denmark, Norway and Sweden. We are also indebted for nearly all our most accurate knowledge of the natural history of Greenland, Iceland and Spitzbergen to the hardy and adventurous sons of the Norsemen, who first visited those islands for discovery and conquest. And it is a fact that in those countries where the land is most barren in organized life, the most valuable knowledge of biology has been acquired. With a few exceptions no one has done more to advance zoology in the highest sense than Professor Michael Sars. The marine zoologists of our own country owe him a peculiar debt of gratitude, for his writings have been a constant source of information, and better still a stimulus to do more thorough and lasting work.

The present memoir consists of detailed and beautifully illustrated descriptions of new additions to the marine fauna of the bay of Christiania. The figures have been drawn by Dr. G. O.

*Bidrag til Kundskab om Christianiafjordens Fauna. II. Af Michæl Sars. (Prepared from his manuscript by his son, G. O. Sars.) Christiania, 1870. 8vo. pp. 114, with six plates.